TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS FOR DEGREE IN

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2204: PHYSICAL ELECTRONICS I

END OF SEMESTER EXAMINATIONS
SERIES: APRIL 2014
TIME: 2 HOURS

INSTRUCTIONS:

- This paper has **FIVE** questions
- Answer any **THREE** questions.

This paper consists of Three printed pages

QUESTION 1 (Compulsory)

a) The results of emission spectra experiments led Neils Bohr to construct a model for the hydrogen atom, based on the mathematics of planetary systems. If the electron in the hydrogen atom has a series of planetary type orbits available to it, it can be excited to an outer orbit and they canfall to any one of the innder orbits, giving off energy. To develop the model, Bohr made several postulates.

i. State any **TWO** postulates
ii. Derive expression for the electrons allowed energy levels. **(11 marks)**

b) Given that the binding energy of certain atom is E = -12.5 eV, obtain the orbital radius and velocity of the electron in an hydrogen atom. **(5 marks)**

c) Consider a thermistor:

i. Define and describe the principle of operation
ii. Draw the circuit symbol
iii. State **TWO** areas of application **(4 marks)**

QUESTION 2

a) i) Differentiate between mobility, conductivity and resistivity.
ii) Calculate the room temperature resistivity of intrinsic silicon. **(6.5 marks)**

b) i) Explain the difference between non-degerate and degenerate semiconductor.
ii) Derive an expression for the total number of electrons in the conduction band at equilibrium for the non-degenerate semiconductor.
iii) Hence determine the relationship between intrinsic fermi level and the center of the forbidden band. **(7 marks)**
iv) Silicon at T = 300K contains an impurity concentration of $N_A = 10^{16}$ cm^{-3}. Determine the concentration of donor impurity atoms that must be added so that the silicon is u-type and the Fermi energy level is 0.20eV below the conduction band edge. **(5 marks)**

QUESTION 3

a) i) State de Broglie relationship and explain its significance
ii) Calculate the first **THREE** energy levels of an electron in an infinite potential well of width $5A^0$.
iii) State any **FOUR** applications of quantum mechanics. **(11 marks)**

b) i) With the aid of a well labelled explain the relationship between the energy distribution function and the absolute temperature.
ii) If the Fermi level is 2.3eV below the conduction band edge the probability of occupancy of the lowest energy state in the conduction band is 10%. Verify this statement. **(9 marks)**

QUESTION 4

a) i) Draw the energy band diagram for the p-n homojunction at equilibrium.
ii) Explain any evidence of the presence of an electric field in the junction. **(5 ½ marks)**

b) Consider a zenertdiode.
i. Draw schematic symbol and with aid of well labelled characteristic curves, briefly explain the operating principle.
ii. State **TWO** areas of application. **(4 ½ marks)**

c) i) Explain the purpose of the intrinsic layer between the n-and p-type layers in a p-intrinsic-n (PIN) diode.
ii) Derive an expression for built-in voltage for a p-u junction.
iii) Calculate the value of the built-in voltage for a silicon p-n junction in which the u-region is uniformly doped with 10^{16} net donors per cm^3 and the p region has a uniform net acceptor concentration of $10^{15}cm^{-3}$. **(6 ½ marks)**

d) i) Describe tunneling phenomenon.
ii) State **TWO** factors that affect tunneling. **(3 ½ marks)**

QUESTION 5

a) i) With the aid of energy band diagrams, explain qualitatively the difference between a metal, insulator and semiconductor.

ii) Explain why a semiconductor acts as an insulator at 0^0K and why conductivity increases with increasing temperature.

iii) Find the maximum resistance of a rectangular block of germanium of dimension 10mm x 1mm x 2mm if it can be connected between any pair of parallel forces. Assume there are $10^{21}m^{-3}$ mobile electrons with a charge of 1.6 x 10^{19}C each and the electron mobility is $0.39m^2V^{-1}S^{-1}$.

(10 ½ marks)

b) The probability that an energy state in the conduction band edge, Ec of Si is 10-4.

i. Calculate the type of semiconductor.

ii. Find N_D- N_A **(5 ½ marks)**

c) i) Describe the Hall effect

ii) State **TWO** applications of Hall effect. **(4 marks)**